protoDUNE Measurements

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BNL-SBU Meeting

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Current BNL Involvement

- See my talk in August LI local meeting:
  - https://indico.bnl.gov/conferenceDisplay.py?confId=2353
- General simulation:
  - Elizabeth
  - No major outstanding tasks currently
  - Geometry could be better, eventually including CRT panels will be important
- Space charge simulation and calibration:
  - Mike, Elizabeth, Matt, students
  - Summer project to study illumination of TPC with crossing tracks needs to be finished
  - Full MC study of calibration scheme needed
- Computing/data management considerations
  - Maxim, Brett

From protoDUNE sim/reco meeting

ProtoDUNE reconstruction: current activities

*presenters today

- **MCC's: TPC sim/reco productions** (so far cosmics muons, particle gun): *Elizabeth Worcester + students, fellows, Tingjun Yang, Karl Warburton.
- **TPC detector simulation**: SP: Martin Tzanov, Elizabeth Worcester, person from in2p3 for DP sig.sim (and lots of efforts for signal simulation and processing in FD group)
- **Beam events reconstruction**:
  - Particle identification: Warwick: Nick Grant, Martin Haigh et al. (also look at Pandora reco chain in collaboration with Cambridge).
  - Hadronic shower reconstruction: *Jiyeon Han,*Andrea Scarpelli, Stefania Bordoni.
  - Containment/missing energy reconstruction: Pawel Guzowski.

  → Needed input what particles, energy range would be necessary to make studies (MCC7 has one energy bin for each particle, but adding samples on request is simple, DP now using FD geometry → 6x6x6 geom needed).
- **Cosmic muon reconstruction**:
  - Reconstruction efficiency: Kevin Wood (currently very busy but will come back in ~2 months).
  - Stopping muons: Dorota&Robert, Aaron Higuera.
- **Beam events with cosmic muon reconstruction**:

  → The last talk will show needed direction of reconstruction.

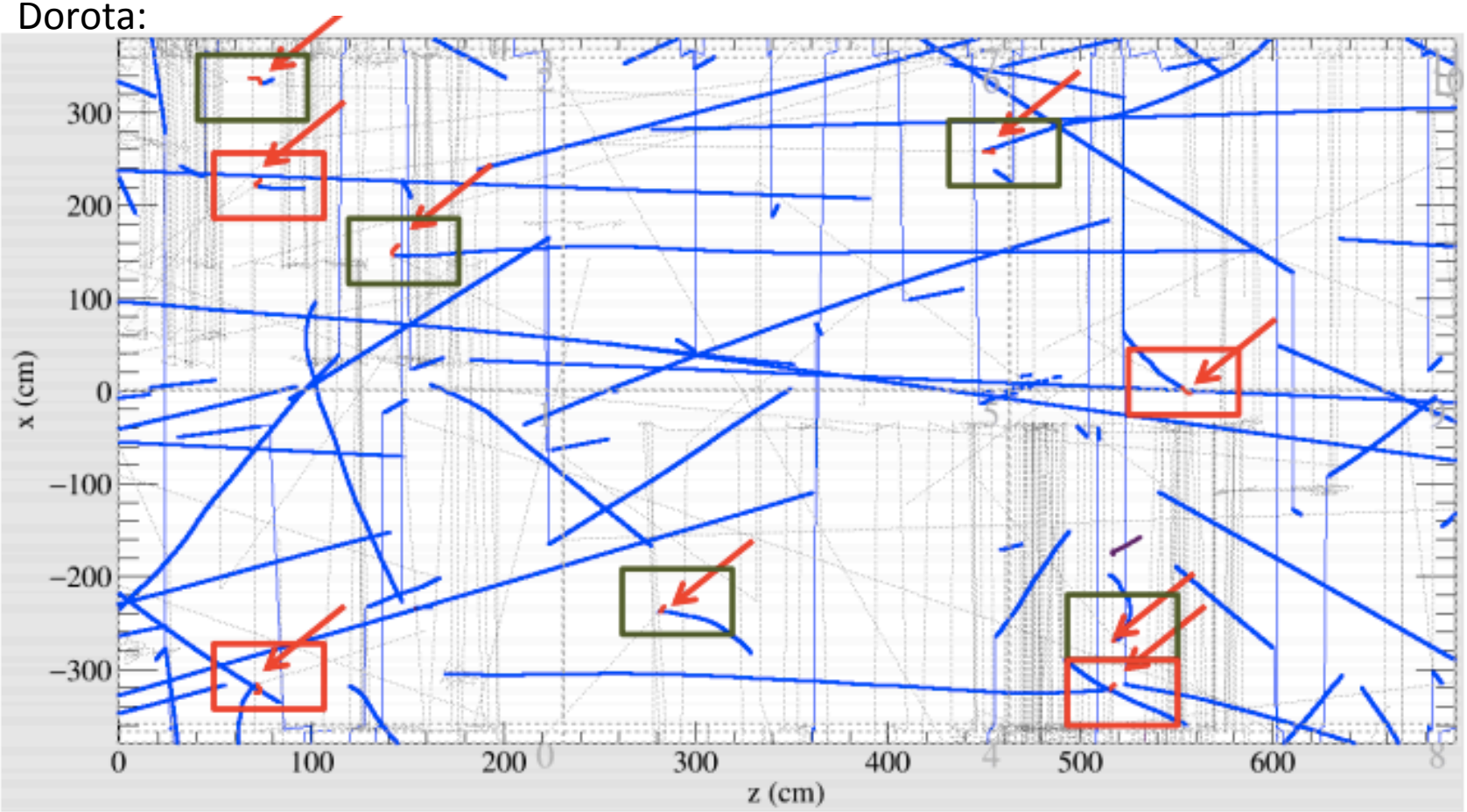
Robert/
Dorota

Cosmics Studies

- See Dorota's talk at protoDUNE sim/reco meeting:
  - https://indico.fnal.gov/conferenceDisplay.py?confId=13039
- Cosmics form an important data set in themselves for TPC calibration and also complicate analysis of beam events
- Kevin observed inefficiency in cosmic track reconstruction, possibly missing "stitching" algorithm for CPA crossers
  - Followup on this observation needed
  - If "stitching" theory is correct, algorithm development needed
- Need to determine t_0 for cosmic tracks
  - Study track-CRT hit matching
  - Study track-flash matching
  - Study t_0 determination for APA and CPA crossers
- Identification of Michel electrons, what fraction will be clean enough for calorimetry?
- Identification of and removal of cosmic tracks from beam events
  - How many beam events clean enough for physics study?
  - How effectively can we subtract cosmic events?

Ex: Michel Electrons

Dorota:



protoDUNE Task List

- https://docs.google.com/spreadsheets/d/1qPS5ZwaDtyrMM8GfMvcwoQjyKksz_urL4OMCYYh6yMA/edit?usp=sharing
- Broken into 3 categories:
  - protoDUNE detector performance/calibration
  - Calibration and data/MC comparisons needed for DUNE FD physics
  - protoDUNE physics
- Most topics have names next to them in the work list, but not a lot of progress since CERN workshop in May where list was developed
  - Dedicated student/postdoc effort would have a big impact on almost any topic
  - Many tie in well to DUNE studies

Detector Calibration/Monitoring Tasks

- Alignment
- Purity monitoring
- Space charge calibration
- Cosmic muon reconstruction
  - For use in monitoring tasks
  - For removal from beam events
- Photon detector characterization
- Integrate data from beam instrumentation
- Real-time monitoring software

Towards FD Physics

- EM shower reconstruction
  - Resolution
  - Energy scale
- Muon reconstruction
  - Resolution (stopping/exiting)
  - Energy scale
  - Michel electrons
  - Muon capture for charge ID
- Hadron shower reconstruction
  - Missing energy
  - Energy scale with varying level of event complexity
- e/γ separation for NC background rejection
- Particle ID efficiency measurements

protoDUNE Physics

- Hadronic showers
  - Multiplicity
  - Topology and development of showers
- Multiplicity in hadron interactions
- Pion interaction cross sections
- Kaon cross sections
  - Need to identify secondary kaons
- Exotic physics – ideas?

Needed skills

- AnaTree ntuple exists for most MC data sets, so contributions can be made using only basic ROOT analysis skills
- LArSoft obviously useful for simulation, reconstruction, more detailed analysis
  - Significant LArSoft expertise at BNL: Mike, Jyoti, Elizabeth, Matt, Chao, David A. (probably others) have all done some level of LArSoft development and are happy to help
  - LArSoft training course from summer 2015 lectures and exercises still available
  - Young DUNE had LArSoft training at last collaboration meeting, perhaps this can be repeated
  - Various DUNE physics working groups have a "hack days" to get people started
    - protoDUNE science workshop was supposed to be this, but ended up being something else – if there's enough interest we could propose one

Conclusions

- Contributions needed almost everywhere!
- I am interested in continuing protoDUNE analysis work and happy to work more closely with SBU students/postdocs
- Work that is already ongoing in BNL and SBU groups involves cosmic ray analysis
  - Seems like a natural place to start/continue
- Physics topics exist
  - Need to understand from SBU which of these physics topics is "thesis-worthy" and/or whether a combination of these measurements and a study of how they impact DUNE would be thesis-worthy
  - Clever ideas of what else we can do with this detector (particularly with cosmic data after the beam run) would be very welcome